

## Simulating Gravitational Attraction Activity – Laurie Kerrigan

Hold the center tube so that the washers hang downwards and the stopper will swing in a horizontal circle when you exert a small force. Keep the stopper swinging with the minimum consistent force you can.

- a) How does this represent a planet's motion and the forces that cause it?
- b) How can you make the planet (rubber stopper) go faster? Slower?
- c) How do radius and speed relate?
- d) Does this agree with the fact that Jupiter takes almost 12 times longer than the Earth to go once around the sun?
- e) In galaxies, the stars further from the galactic center spin with about the same tangential velocity as those closer in, make this apparatus demonstrate this. How can you do this?
- f) This observed phenomena of star motion in galaxies raised the question of dark matter. Why would this motion do that?

### Further applications: Planet Rotations

Use this data to graph velocity of planet's orbit vs. distance from the sun. You can use the excel program on the computer or paper. AU is an astronomical unit, which equals the average distance from the sun to the Earth.

<u>Planet</u>	<u>Distance (AU)</u>	<u>Velocity (km/s)</u>
Mercury	.383	47.4
Venus	.723	35.0
Earth	1.00	29.8
Mars	1.52	24.1
Jupiter	5.20	13.1
Saturn	9.53	9.64
Uranus	19.2	6.80
Neptune	30.1	5.43
Pluto	39.5	4.67

- a) That type of relationship does this graph demonstrate?
- b) How does rotational velocity relate to distance from the sun?
- c) What force causes this rotational velocity and in what direction is it acting?
- d) Referring to the gravitational equation and using the words acceleration and tangential velocity, explain why this data makes sense.

## Galaxy Rotations

Use this data to graph velocity of star vs. distance from the galactic center.

A parsec is  $3.09 \times 10^{16}$  m. (from parallax of one arc second)

Distance (Kilo parsecs)	Velocity (km/s)
0.5	50
1	60
2	90
3	110
4	125
5	125
6	125
7	130
8	130
9	132
10	135
11	135
12	130
13	130
14	135
15	135

- If you ignore the small distances (0.5–3 kiloparces), what can you state about the tangential velocity of material orbiting the galactic center?
- Does the gravitational force equation explain this?
- Why couldn't you mimic this behavior with the rubber stopper apparatus?